RESEARCH DEPARTMENT

PHOTOGRAPHIC RECORDS OF THE EFFECT OF RANDOM NOISE ON A TELEVISION PICTURE

Report No. G-058

(1955/18)

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

PHOTOGRAPHIC RECORDS OF THE EFFECT OF RANDOM NOISE ON A TELEVISION PICTURE

Report No. G-058

(1955/18)

G.F. Newell, A.M.I.E.E.
J.G. Spencer

WProctor Wilson

(W. Proctor Wilson)

This Report is the property of the British Broadcasting Corporation and may not be reproduced or disclosed to a third party in any form without the written permission of the Corporation.

Report No. G-058

PHOTOGRAPHIC RECORDS OF THE EFFECT OF RANDOM NOISE ON A TELEVISION PICTURE

Section	Title	Page
	SUMMARY	1
1	INTRODUCTION	1
2	DEFINITION OF THE SIGNAL-TO-NOISE RATIO	1
3	PHOTOGRAPHY	2
4	SUBJECTIVE COMPARISONS	2
5	CONCLUSIONS	3

July 1955

Report No. G-058
(1955/18)

PHOTOGRAPHIC RECORDS OF THE EFFECT OF RANDOM NOISE ON A TELEVISION PICTURE

SUMMARY

A test card reproduced on the screen of a television receiver has been photographed for a range of input-signal levels, thus giving a range of signal-to-noise ratios. In order to correlate subjective impressions with the photographic records, the latter were compared with the original pictures by a number of observers. The photographs were judged to appear slightly less noisy than the originals, but the average difference corresponded to less than 1 dB change in the input signal-to-noise ratio. The photographs may therefore be considered realistic records of the pictures on the receiver screen.

1. INTRODUCTION.

For demonstration purposes photographic records of pictures on the screen of a television receiver were required for a range of signal-to-noise ratios. The picture used was the B.B.C. Test Card C; it was generated by a monoscope.

The receiver was of a modern commercial type, with a seventeen-inch rectangular tube. It incorporated an efficient a.g.c. system which enabled small changes of signal-to-noise ratio to be achieved without any appreciable change of contrast, by altering the input-signal amplitude.

2. DEFINITION OF THE SIGNAL-TO-NOISE RATIO.

The parameter of the input signal quoted in this report is the r.m.s. voltage corresponding to the peak-white condition. The noise voltage is the theoretical r.m.s. value in a 75-ohm source having a bandwidth equal to that of the receiver, multiplied by the receiver noise factor at the appropriate input-carrier amplitude. The receiver a.g.c. altered the gain of the radio-frequency amplifying stage, and as a result the noise factor varied with input-signal amplitude.

Some workers prefer to use d.a.p. (double-amplitude-peak) values. In the case of a video waveform the d.a.p. value is the excursion of voltage between the tips of the synchronising pulses and the peak-white level of the picture. The ratio of the d.a.p. video signal to the r.m.s. value of the noise, measured at the output of the receiver, is the same as the signal-to-noise ratio quoted in this report.

Various ways of measuring or defining the d.a.p. value of random noise are used. Measurements give a peak-to-r.m.s. ratio of approximately 4*. For a normally distributed noise voltage this corresponds to the value exceeded for one ten-thousandth of the total time, but the only justification for using this as the basis for a definition is that it agrees with the measured values. The ratio of the d.a.p. to the r.m.s. value of random noise may therefore be taken as approximately 18 dB. To obtain the d.a.p. signal-to-noise ratio from the values quoted in this report, therefore, 18 dB should be subtracted.

3. PHOTOGRAPHY.

The receiver was adjusted to give a high luminance in the peak-white condition, consistent with a good contrast range. The exposure time was set by means of an electronic shutter circuit which brightened the tube face for the duration of either one or two complete pictures, as required; the mechanical camera shutter was left open until after completion of the exposure.

The lens aperture used was f/4·5 and the negatives were made on H.P.3 plates developed for 11 minutes at 65°F in D163, with a 1:3 dilution. The prints used for the subjective tests were 10 × 8 in. enlargements on Grade 3 paper, and are reproduced approximately full-size at the end of this report.

4. SUBJECTIVE COMPARISONS.

Fifteen observers took part in the subjective comparisons between the photographs and the original pictures. Each was presented with a series of eight photographs, but these were not in an ordered sequence; the signal-to-noise ratio was adjusted until the picture on the screen was judged to correspond most closely with the photograph. The results for an exposure time of 1/25 sec, i.e., the duration of one complete picture, are summarised in Table 1. This shows the mean difference between the apparent and actual signal-to-noise ratios and the standard deviation for each condition, to the nearest 0·5 dB. The photographs appear slightly less noisy than the originals, but the mean difference between the apparent and actual signal-to-noise ratios is less than 1 dB. The standard deviation increases from about 2 dB at low signal-to-noise ratios to 4 dB at high signal-to-noise ratios; it is not surprising that the standard deviation increases as the signal-to-noise ratio increases.

The observers in the group comprised twelve engineers, five of whom were experienced in detecting faults in television pictures and seven not, and three secretarial staff; these categories are referred to as Groups A, B, and C respectively. Table 2 shows the means and standard deviations for the three groups separately. There is a tendency for the mean differences for Group A to be greater than those for the other two groups.

---

[*] A summary of some experimental results is given in "Survey of Existing Information and Data on Radio Noise over the Frequency Range 1-30 Mc/s". D.S.I.R. Radio Research Special Report No. 15, p. 95, published in 1947.

TABLE 1

Exposure time 1/25 sec

Photograph No.	Peak white luminance, ft-lamberts	Input signal-to-noise ratio, dB	Subjective results	
			Mean difference, dB	Standard deviation, dB
1	11	16	−0·5	1·5
2	14	22	0	2·5
3	15	28	1·0	3·0
4	15	31	1·5	4·5

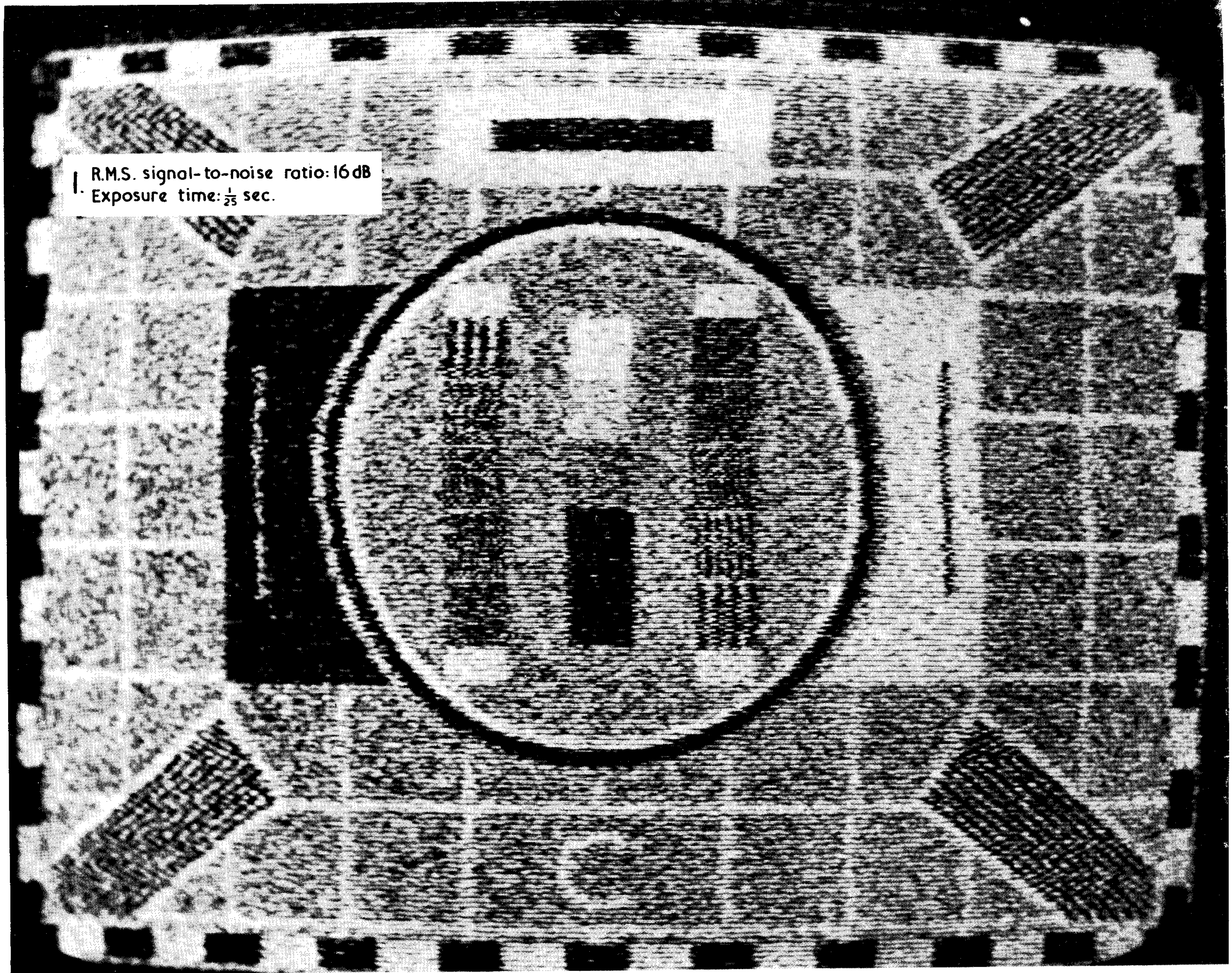
TABLE 2

Photograph No.	Input signal-to-noise ratio, dB	Group A		Group B		Group C	
		Mean difference, dB	Standard deviation, dB	Mean difference, dB	Standard deviation, dB	Mean difference, dB	Standard deviation, dB
1	16	−1·0	1·5	−0·5	1·5	−0·5	1·5
2	22	1·0	3·0	−0·5	2·0	−0·5	2·0
3	28	2·5	2·5	1·0	2·5	−1·5	1·5
4	31	3·0	5·0	0	4·0	0·5	3·0

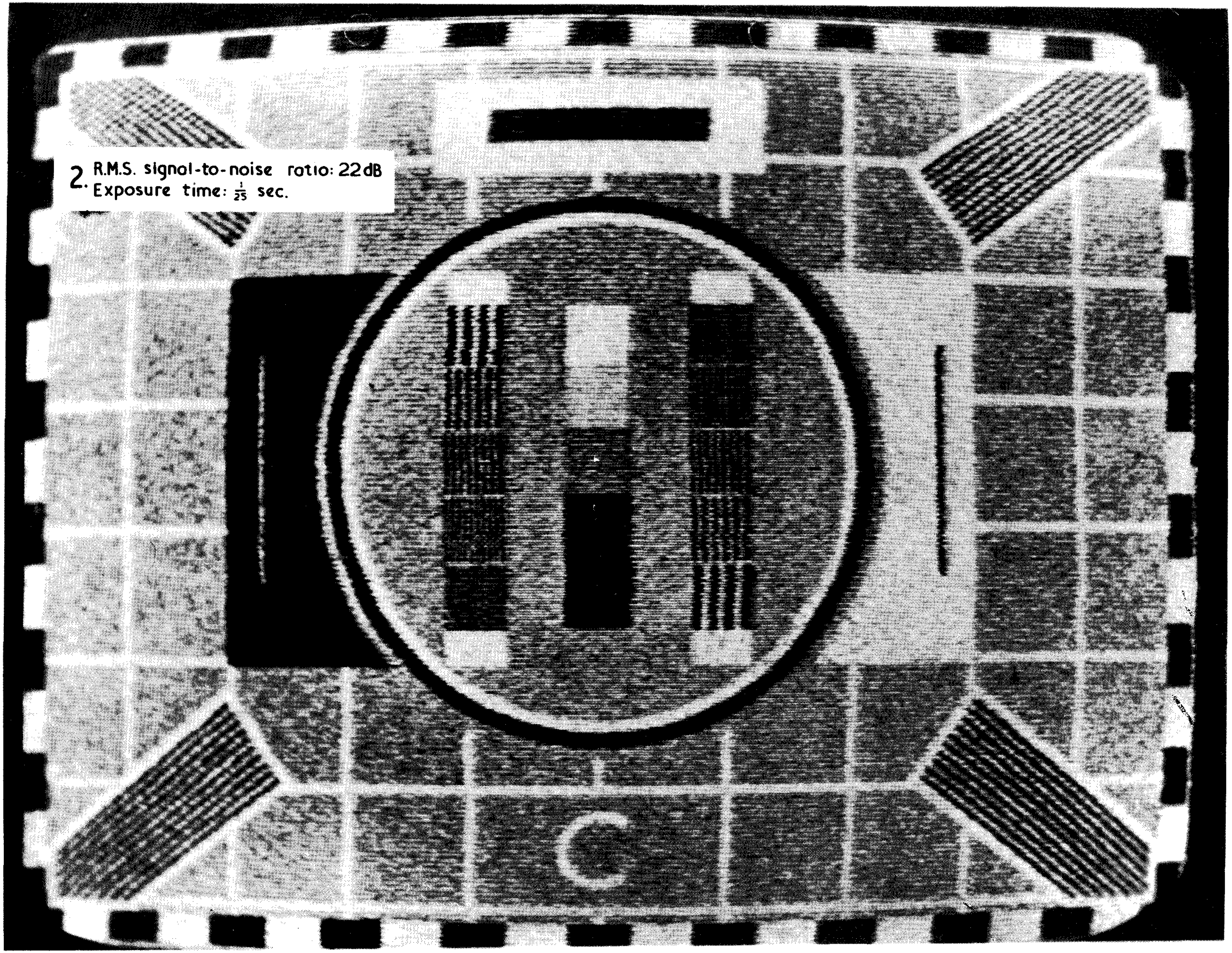
Another series of photographs was taken with an exposure time of 2/25 sec, corresponding to the duration of two complete pictures. The effect of doubling the exposure was to increase the apparent difference between the photograph and the original by an additional 2 dB; this is probably because the picture information is coherent from one frame to the next, whereas the noise is not.

5. CONCLUSIONS.

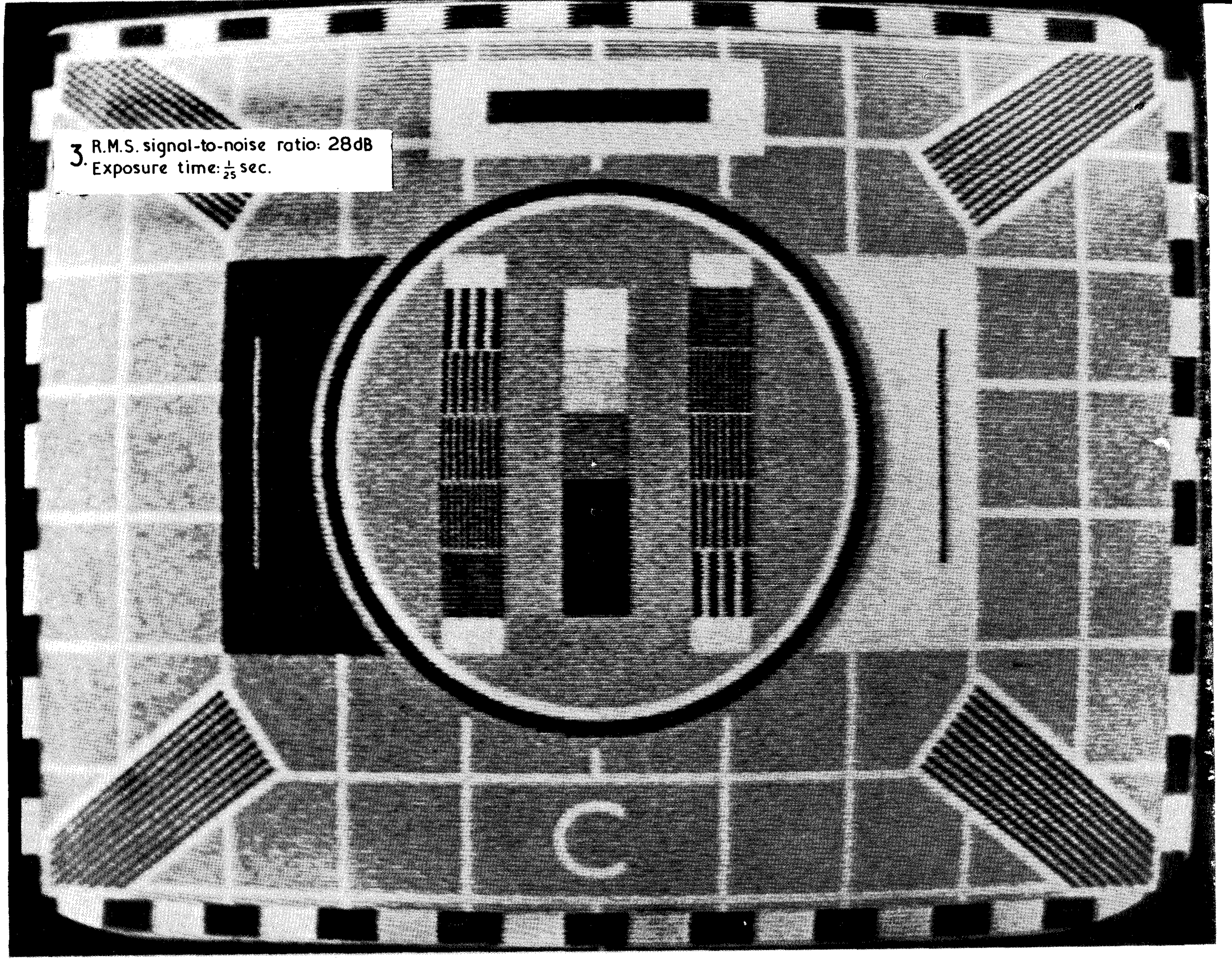
Photographs 1–4 may be regarded as realistic records of the pictures on the receiver screen for the signal-to-noise ratios shown.



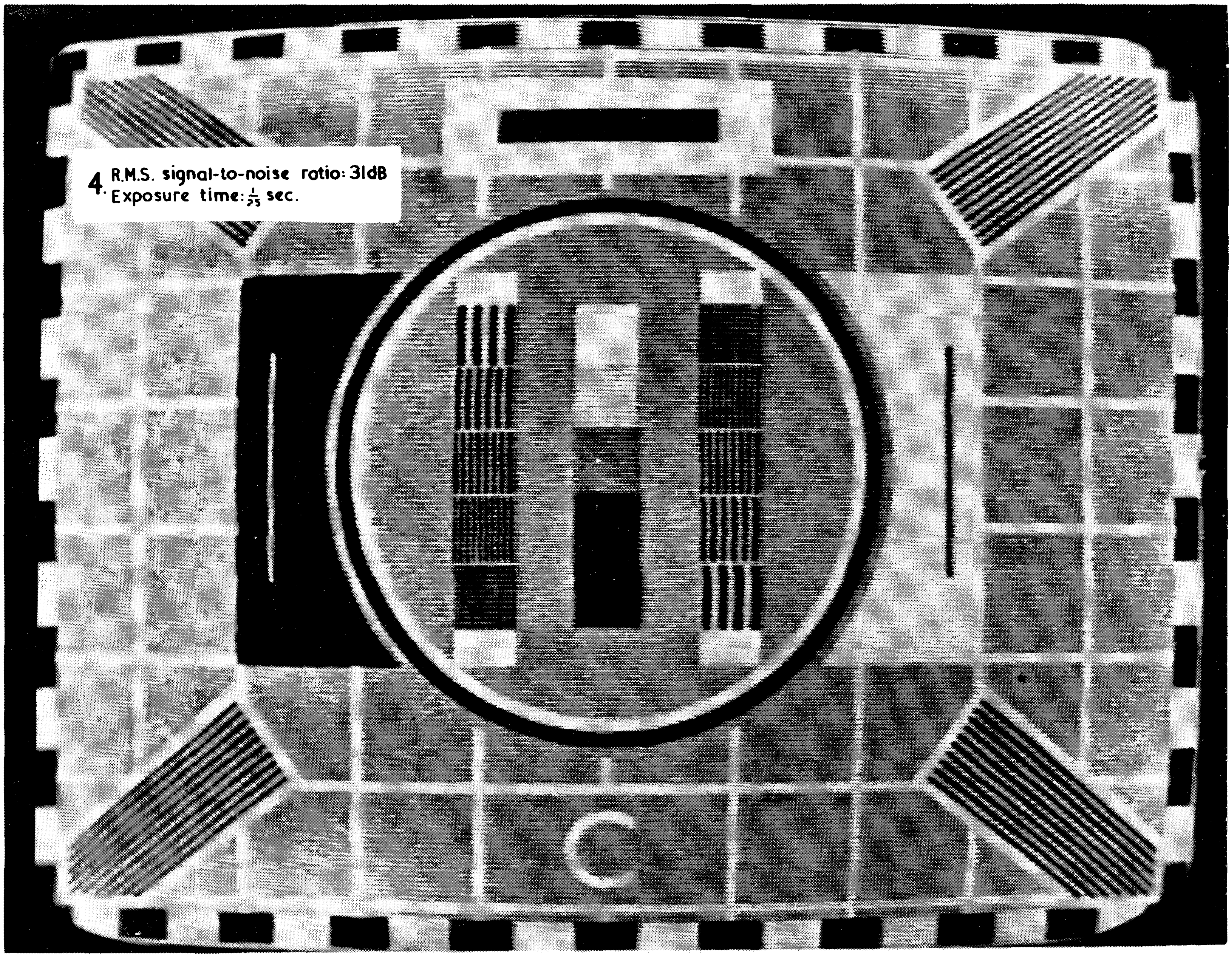
1. R.M.S. signal-to-noise ratio: 16 dB
Exposure time: $\frac{1}{25}$ sec.



2. R.M.S. signal-to-noise ratio: 22dB
Exposure time: $\frac{1}{25}$ sec.



3. R.M.S. signal-to-noise ratio: 28dB
Exposure time: $\frac{1}{25}$ sec.



4. R.M.S. signal-to-noise ratio: 31dB
Exposure time: $\frac{1}{25}$ sec.